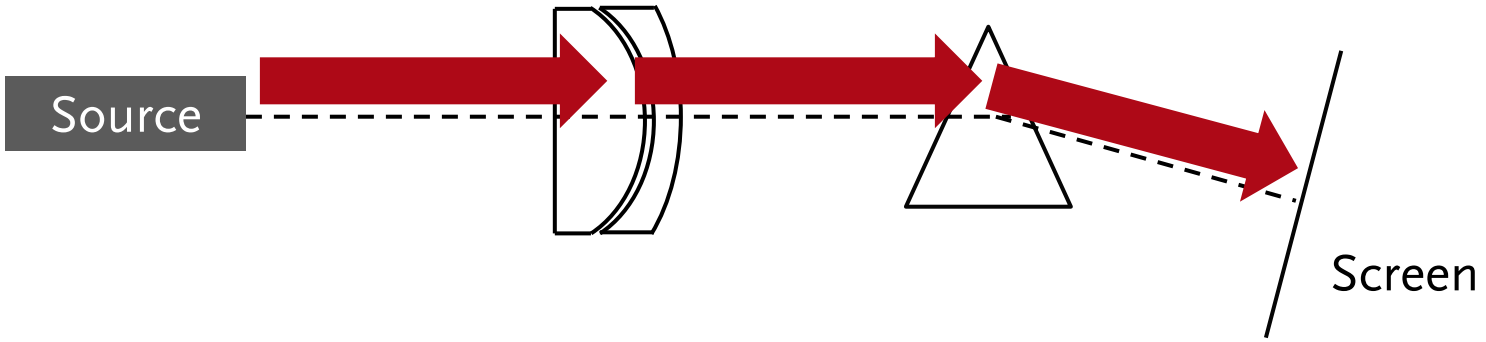
UseCase.0011 (1.0)

# Positioning & Orientation of Elements

**Keywords:** positioning, orientation, element, component, angle, basal, isolated, input channel, output channel, coordinate system, origin, separate, tilt, shift, offset

# Description

- The light path diagram (LPD) is used to define the radiation of sources, structures of optical elements and detectors.
- The user defines path of the light through optical systems.

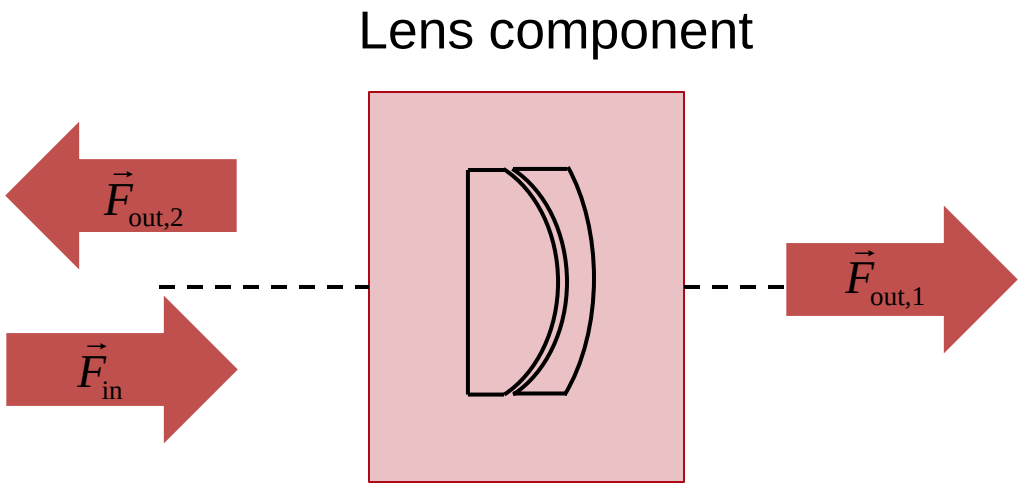



- This use case explains how the positioning and orientation of the light path elements within the light path diagram has to be used.

# Light Path Diagram vs Laboratory

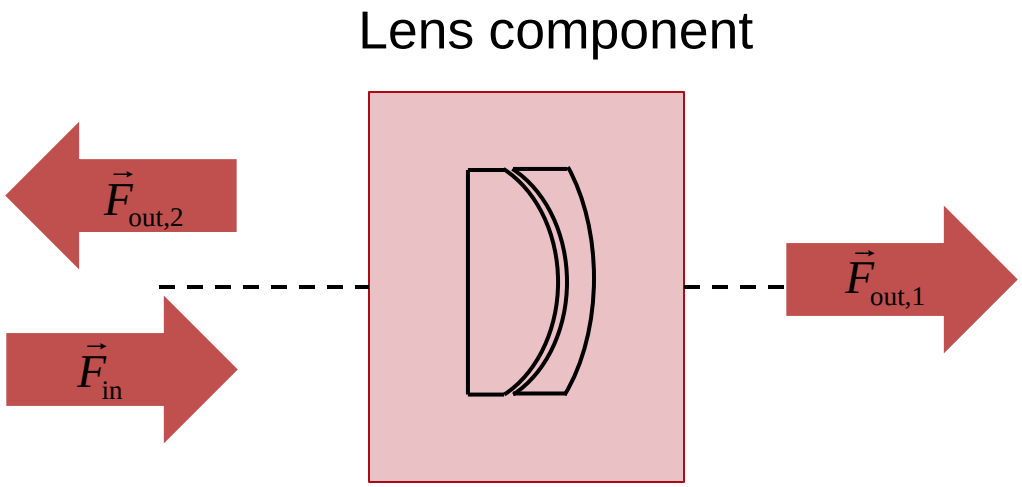
- Optical devices in real laboratory:
  - Light sources
  - Optical components
  - Detectors or optical effect of light
- Elements of light path diagram:
  - Radiation source models (called light source in VirtualLab)
  - Real optical components
  - Ideal optical components
  - Detectors
  - Analyzers
- A component in laboratory does not necessarily be expressed by one component in light path diagram.

# Light Path Elements



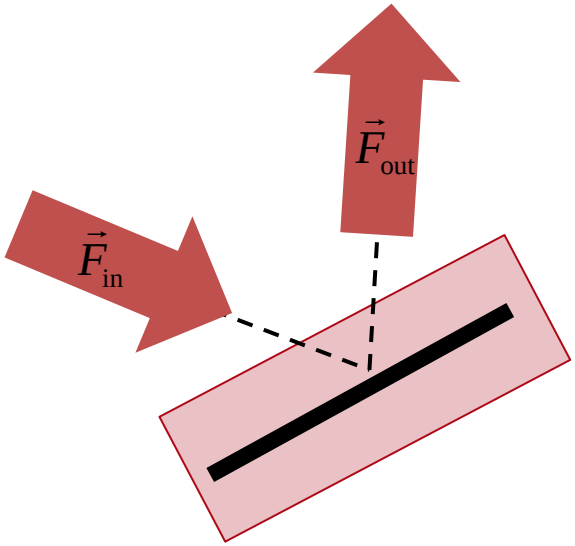

- Light path elements can have multiple input and output channels.
- Input and output channels define axes that correspond to the optical axes used for the system setup.

# Light Path Elements




- Input channels correspond to different incident light distributions coming from different directions/components.
- Output channels correspond to different output light distributions propagating to different directions/components (for example reflected and transmitted light).

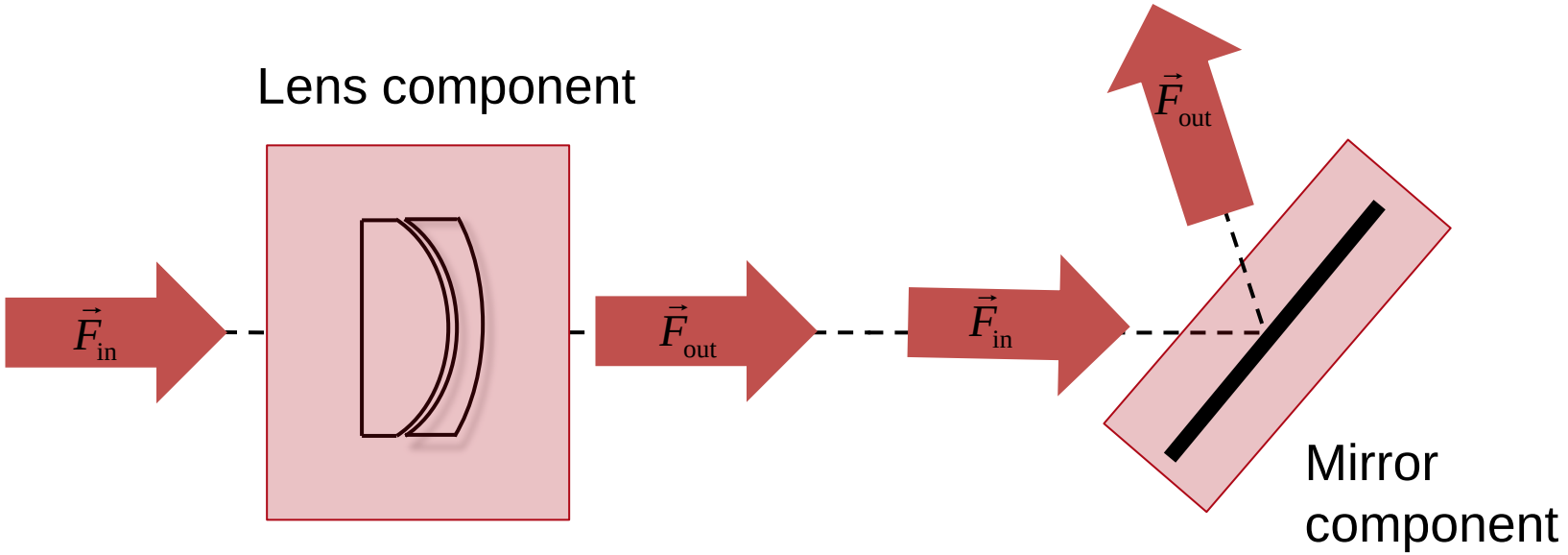
# Light Path Elements




Mirror component

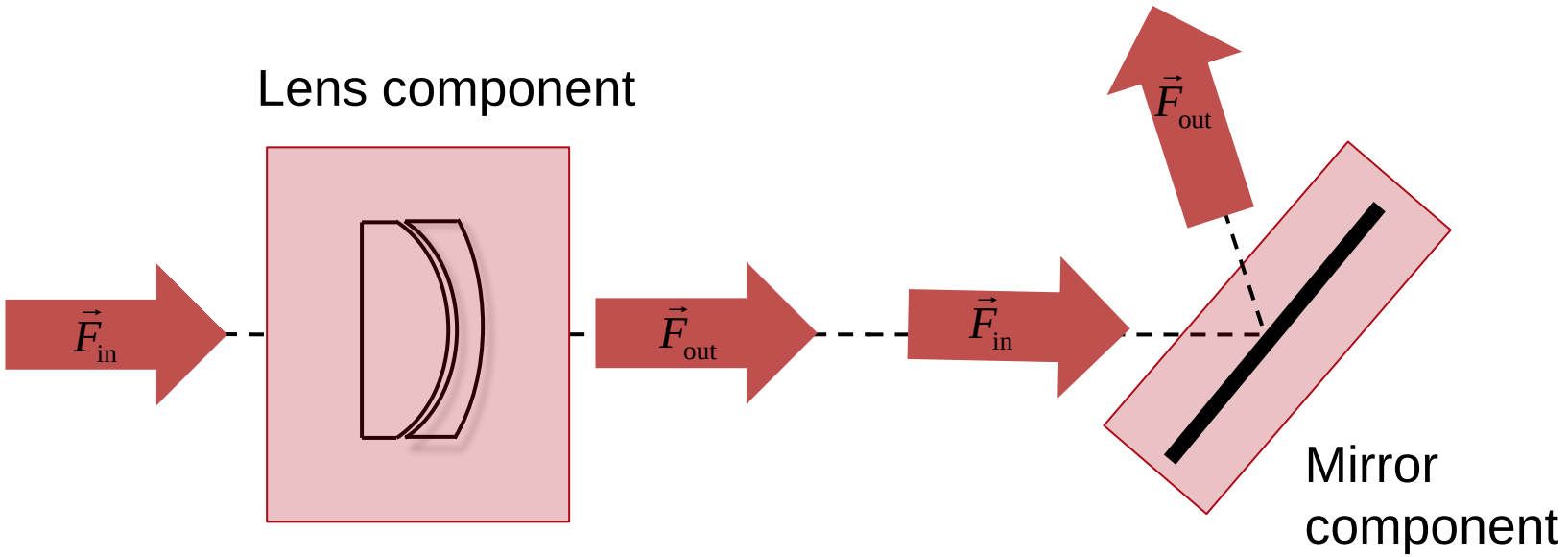
- Axes of channels are predefined or may change depending on parameters of a component.
- Each component ‘knows’ its orientation relative to the axes of the channels.

# Definition of Element Position



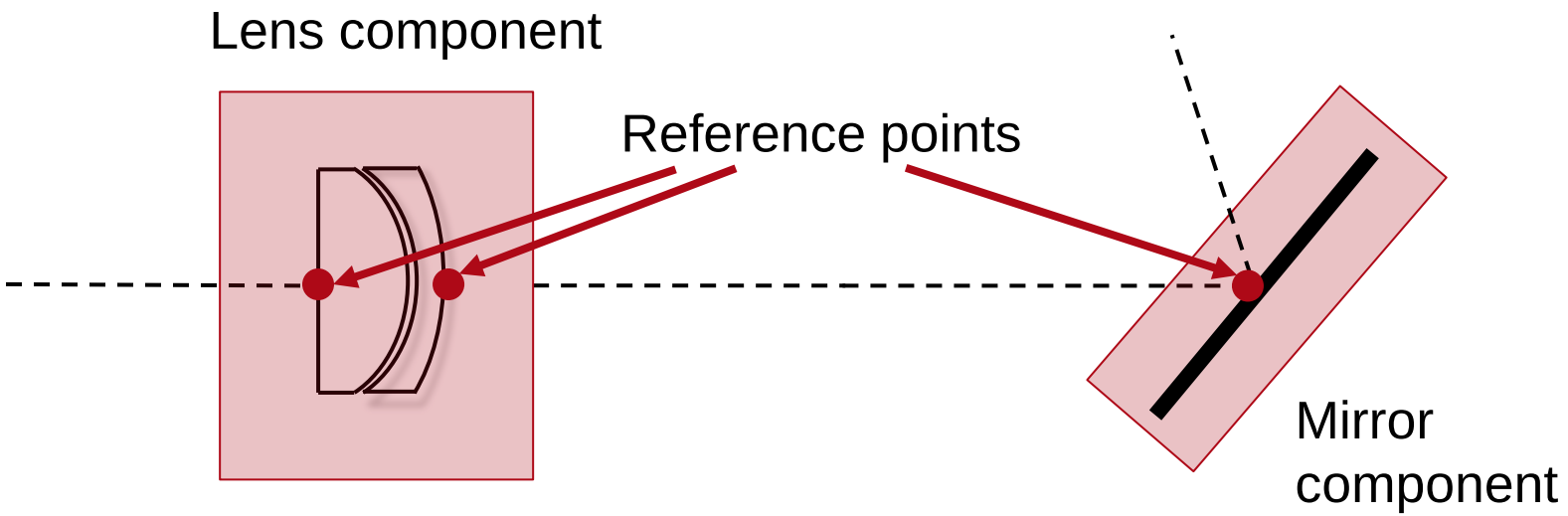

- The axis of one output channel of a component is connected to an axis of an input channel of another component or detector
- All connected components and their corresponding channel axes define the optical axes of the system.

# Definition of Element Position




- Light path elements have absolute positions.
- Origin of absolute coordinate system is defined by light source.
- Tilts of light source are not possible since it is the origin.
- For the positioning of elements relative and/or absolute distances/angles can be used.

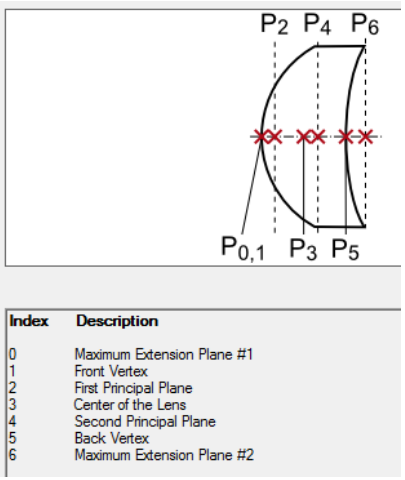
# Definition of Element Position



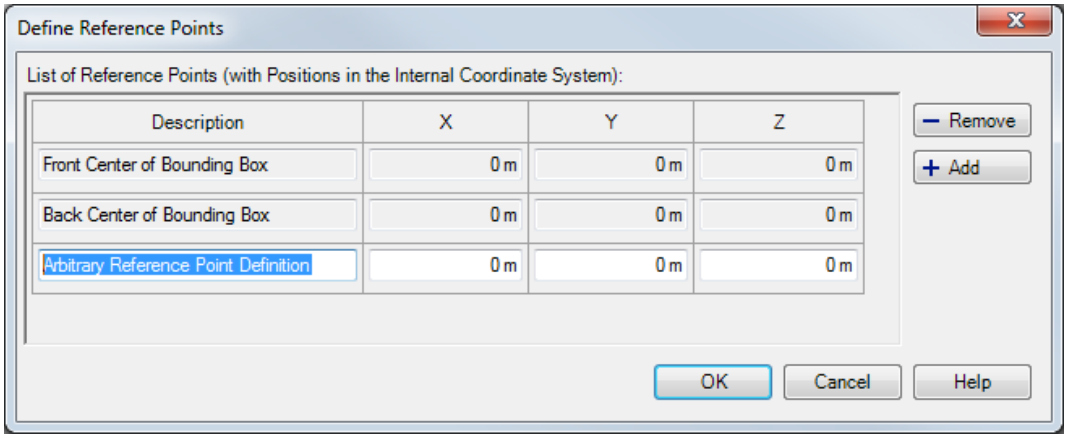

- Every component defines multiple reference points per channel.
- Relative positions of components are measured between reference points.

# Positioning/Orientation Rules

- Distances away from an element are always positive.
- The position/orientation of an element can be done directly in the Edit Dialog of the element or with the help of Coordinate Break elements.
- For each element type there are defined reference points that can be selected. (Only the programmable component allows arbitrary reference points.)

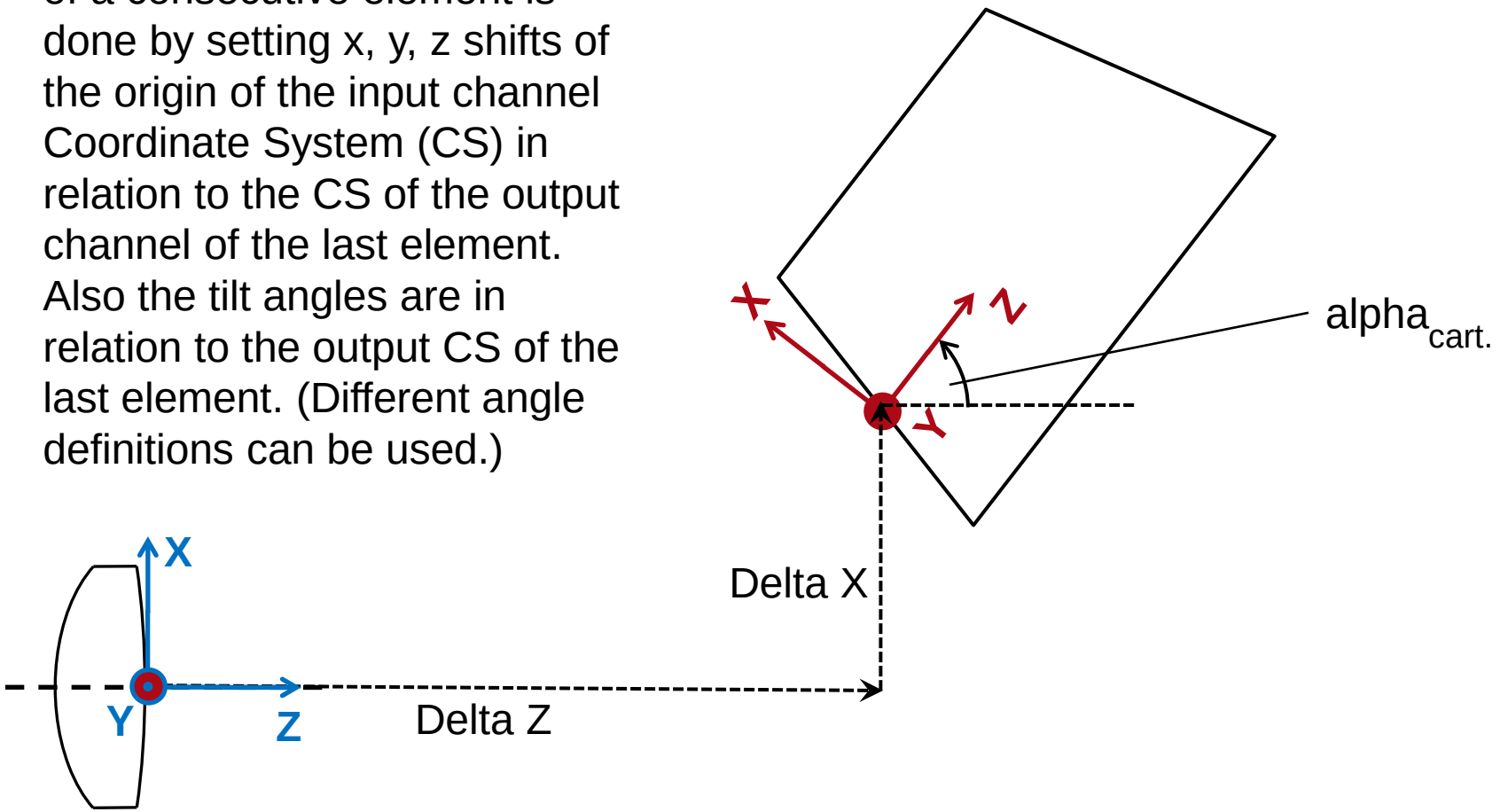



| Index | Description |
|---|---|
| 0 | Maximum Extension Plane #1 |
| 1 | Front Vertex |
| 2 | First Principal Plane |
| 3 | Center of the Lens |
| 4 | Second Principal Plane |
| 5 | Back Vertex |
| 6 | Maximum Extension Plane #2 |



# CSs for Orientation/Positioning

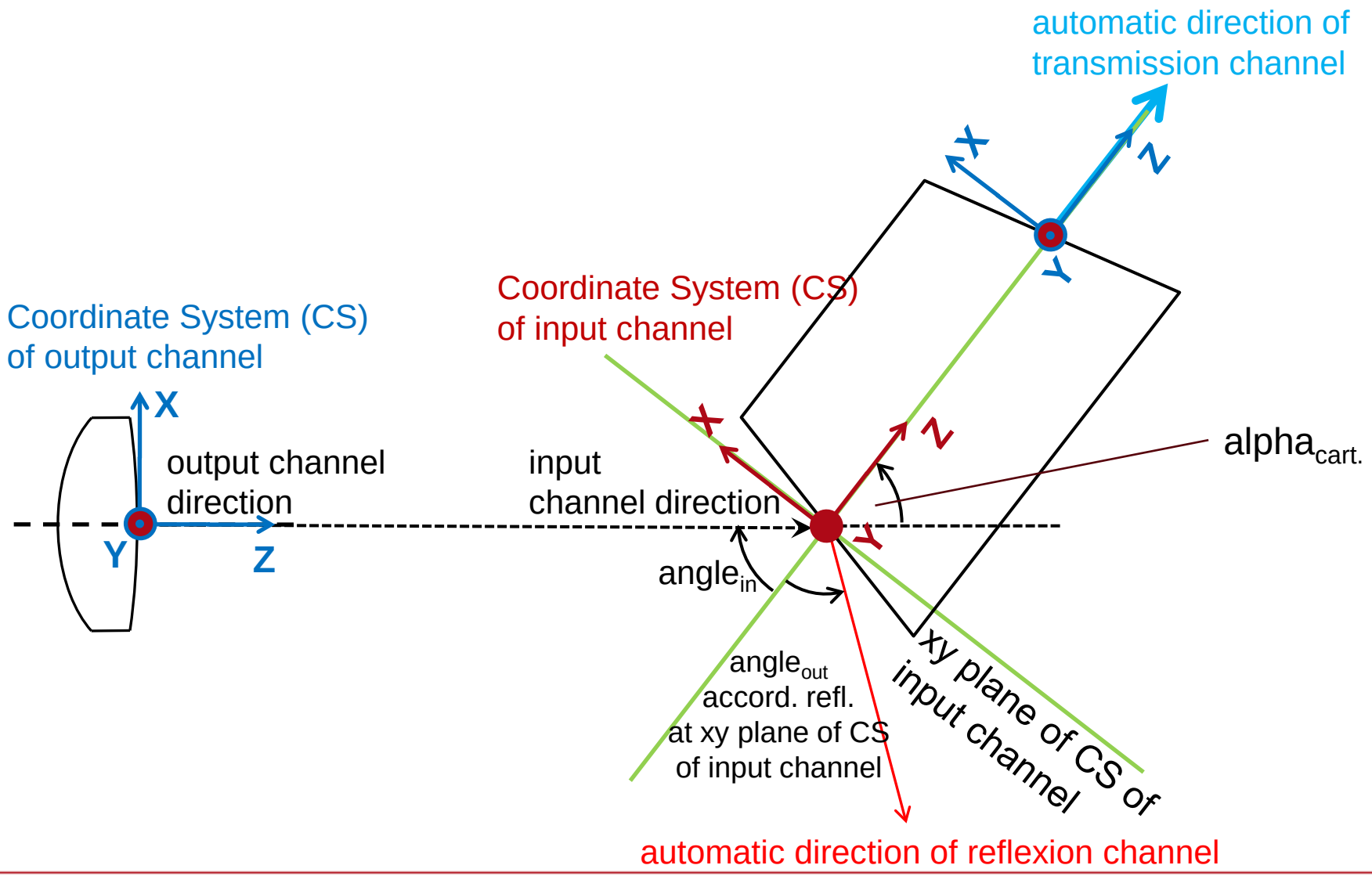
The positioning and orientation of a consecutive element is done by setting x, y, z shifts of the origin of the input channel Coordinate System (CS) in relation to the CS of the output channel of the last element. Also the tilt angles are in relation to the output CS of the last element. (Different angle definitions can be used.)



# Used Directions of Output Channels

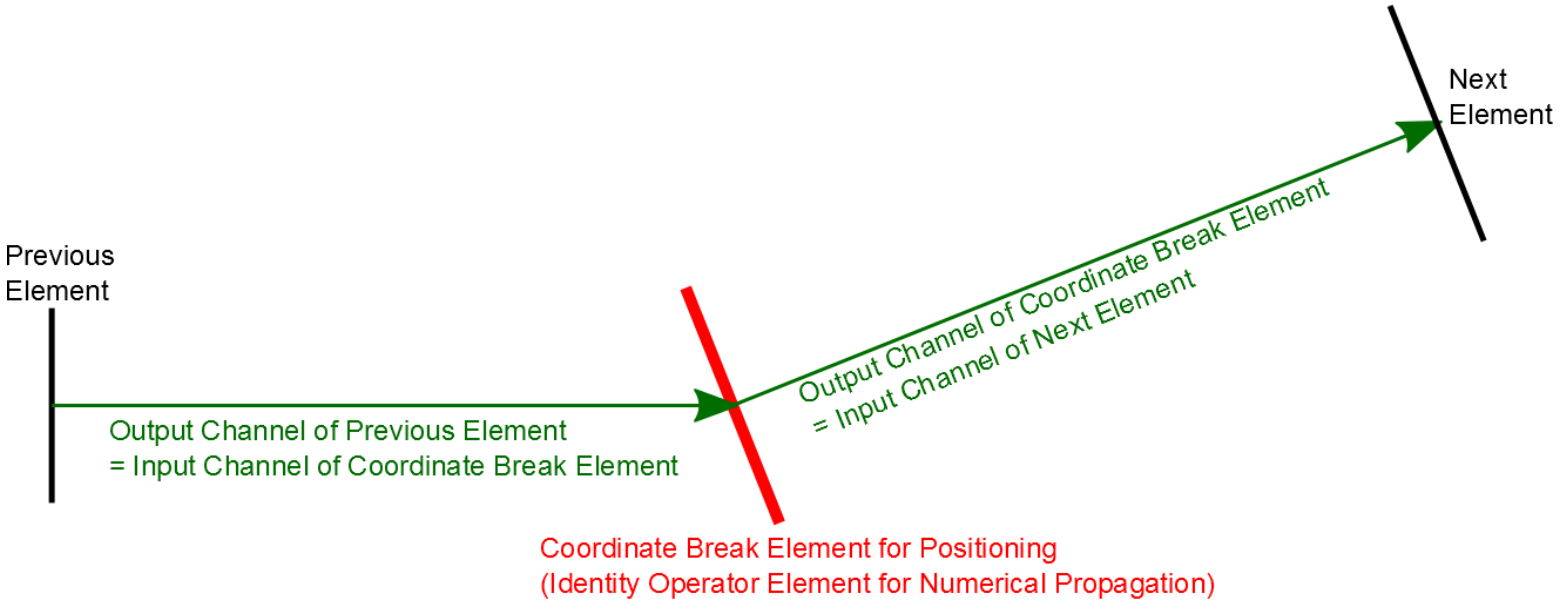
- The reflective output channel takes care of the reflected part of the input light; analogously for the transmitting output channel and the transmitted light.
- But there is no fixed relationship between the direction of the z-axis of the channel‘s coordinate system and the main direction of the propagating light.
- The direction of the reflection channel is calculated according the law of reflection regarding the xy plane of the coordinate system of the input channel. This is done in order to have a good first guess for the propagation direction of the reflected light in many cases.
- For standard systems these automatically considered directions are reasonable and ensure little computational effort. For special cases other directions might be more useful and have to be defined with the help of the Coordinate Break element.

# Automatic Directions of Output Channels

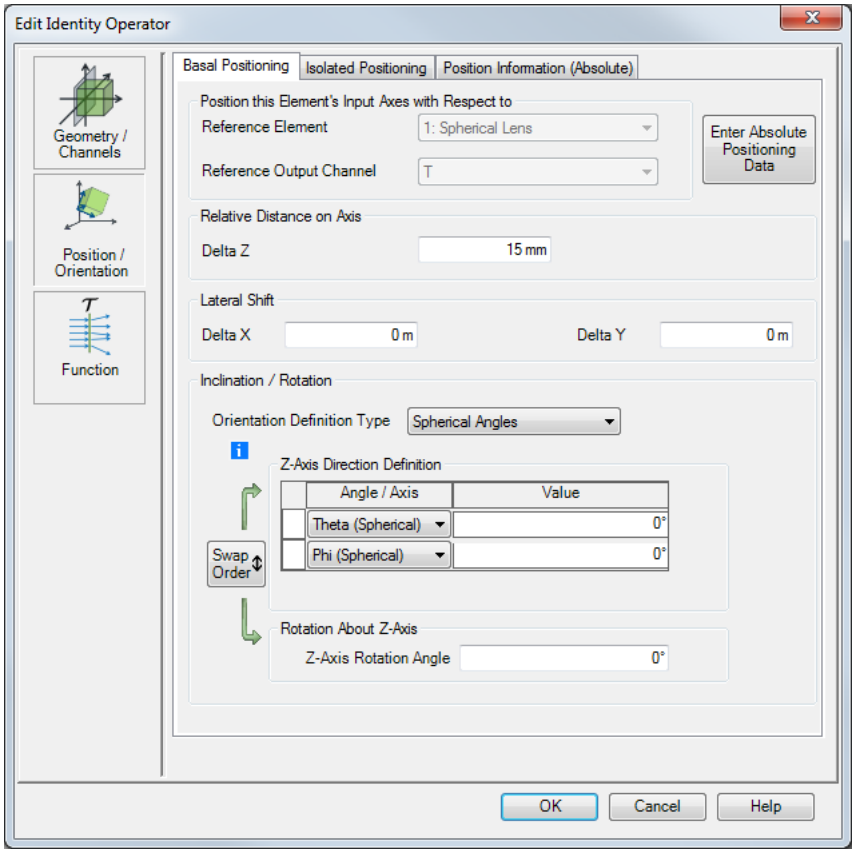


# Coordinate Break Element

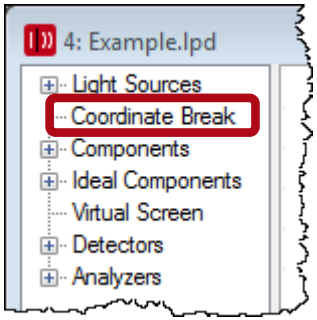
It is also possible to handle position and orientation settings with the help of the so-called Coordinate Break element. It provides compatibility to Zemax setups using its Coordinate Break Elements.



# Coordinate Break Element



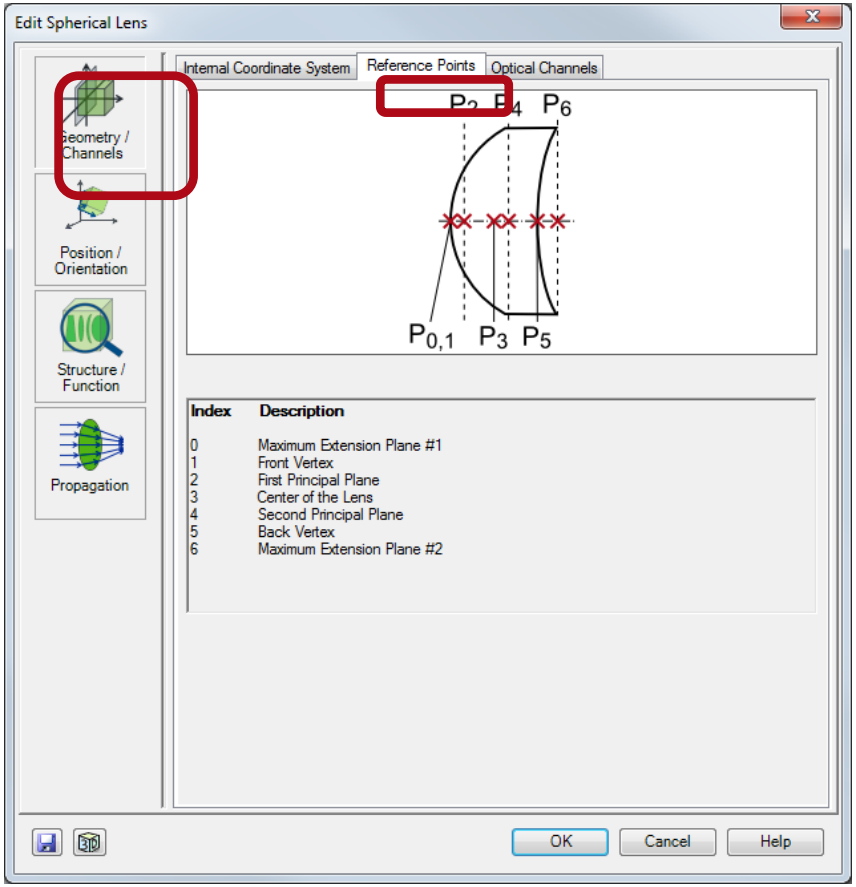

- *Coordinate Breaks* allow the introduction of an offset or tilt independent of a real optical element.
- Position and direction of the optical axis can be changed between two optical elements.



# Position & Orientation Settings

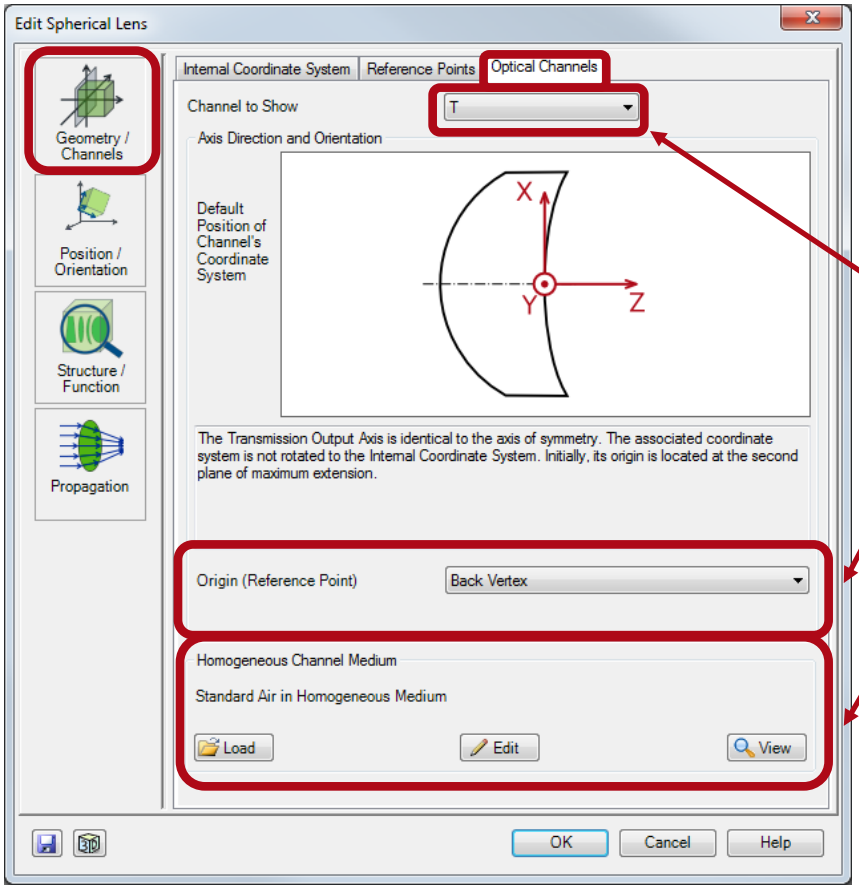
- The following slides will show the possible settings for the positioning and orientation of elements using the example of a spherical lens component.
- All settings are comparable for ideal components and detectors.

# Position & Orientation Settings




Definition of reference points for distance definition

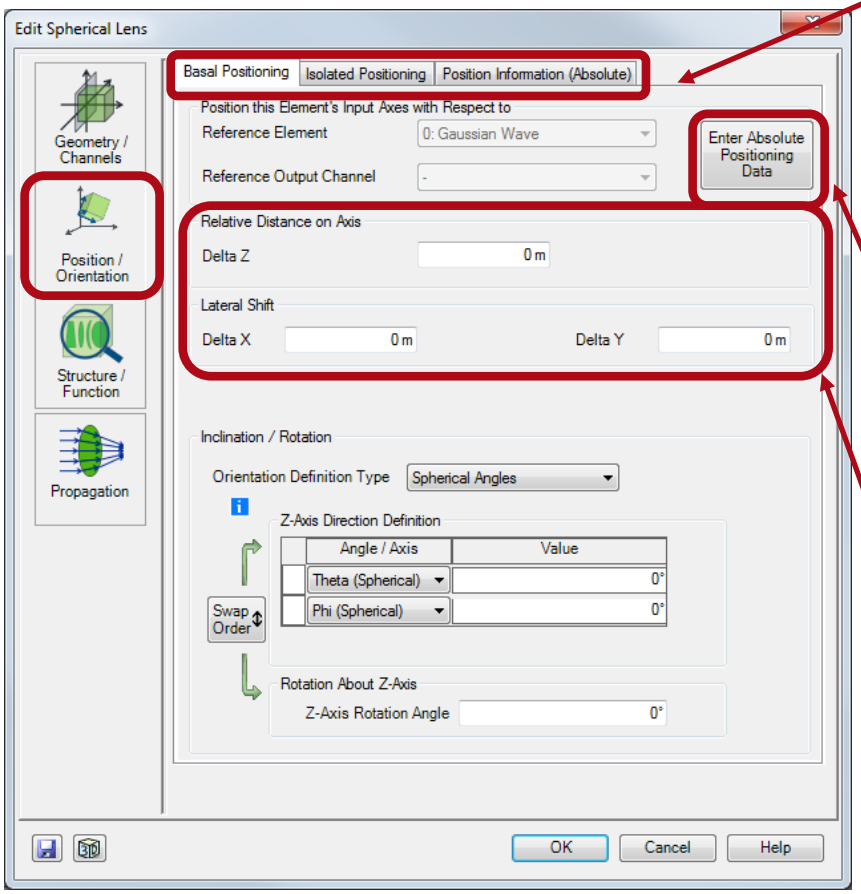
# Position & Orientation Settings




Selection of reference point and medium for each channel

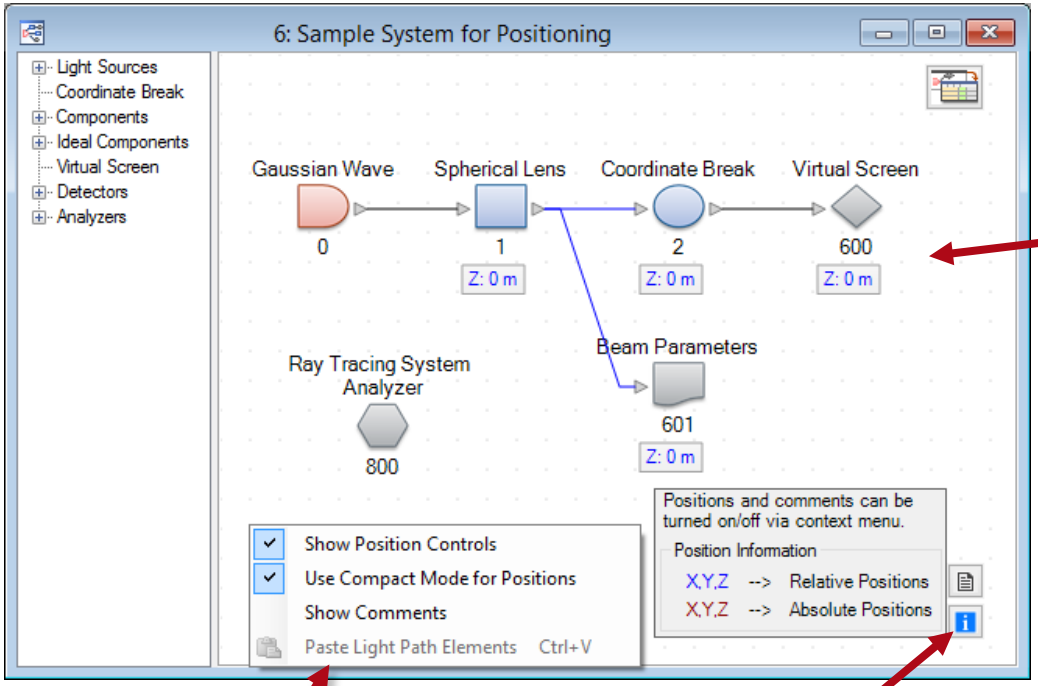
- Selection of channel
- Selection of reference point
- Homogeneous medium containing the channel

# Position & Orientation Settings

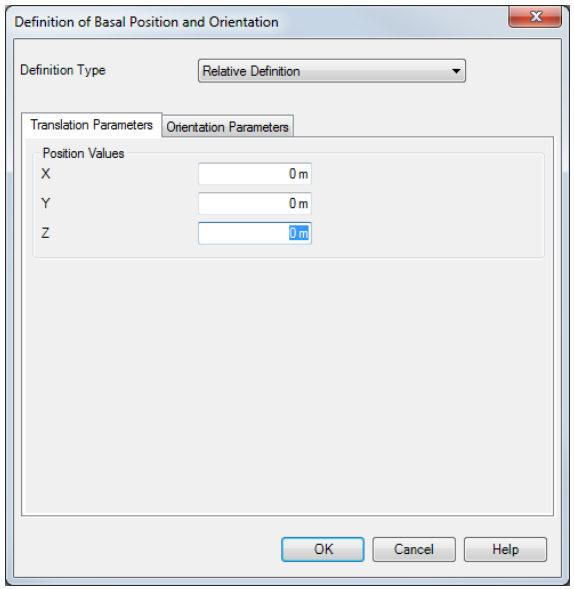



- Basal and isolated positioning as well as information about the absolute position in optical system
- Button opens edit dialog for position settings in absolute coordinate system.
- Distance along z-axis (optical axis) and lateral offset relative to previous component

# Light Path View (Positioning)



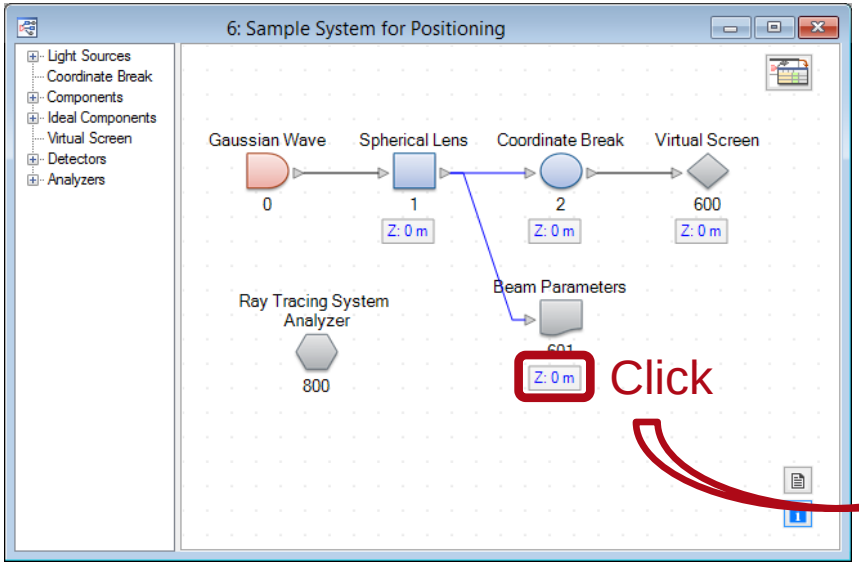

Clicking the position entries opens the corresponding dialog where also absolute positions can be entered.



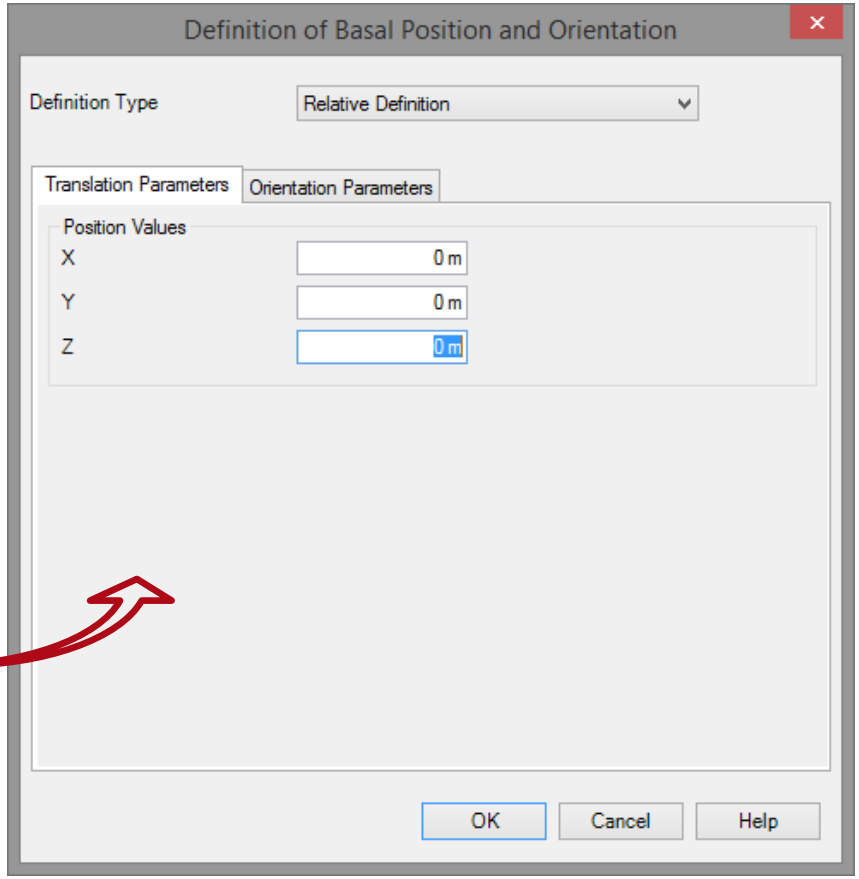

The context menu (right mouse click) allows to disable the display of positions and comments as well as to paste and copy components.

Clicking the „i“ symbol returns information regarding the displayed positions.

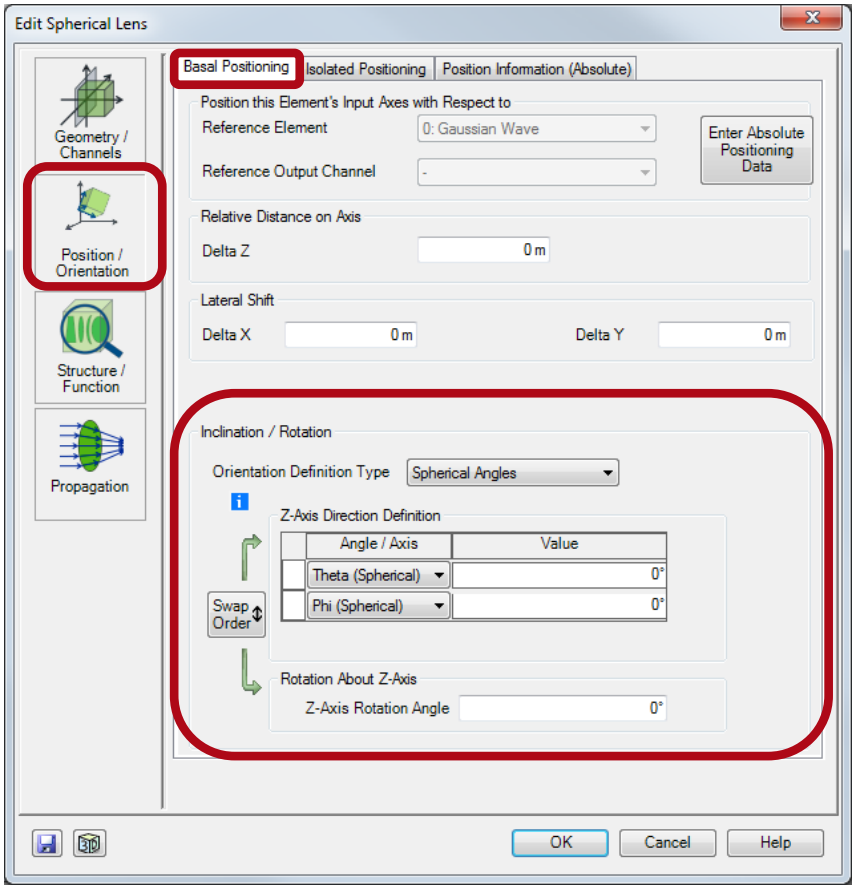
# Position & Orientation Settings




Alternative method for changing of light path element positions



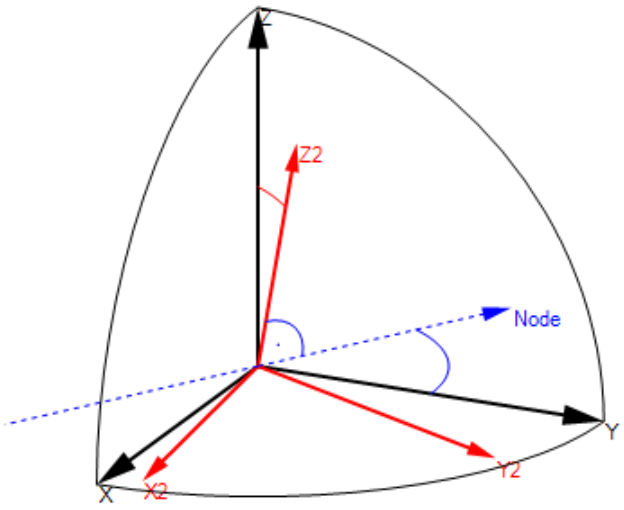
# Position & Orientation Settings




Component tilt with angle definitions:

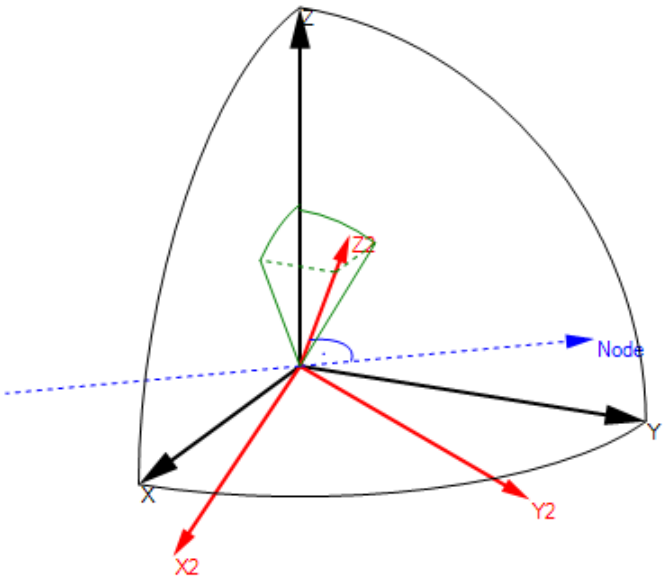
- Spherical angles
- Cartesian angles
- Direction angles
- Eulers angles
- Arbitrary sequence of axis rotations.

# Spherical Angles



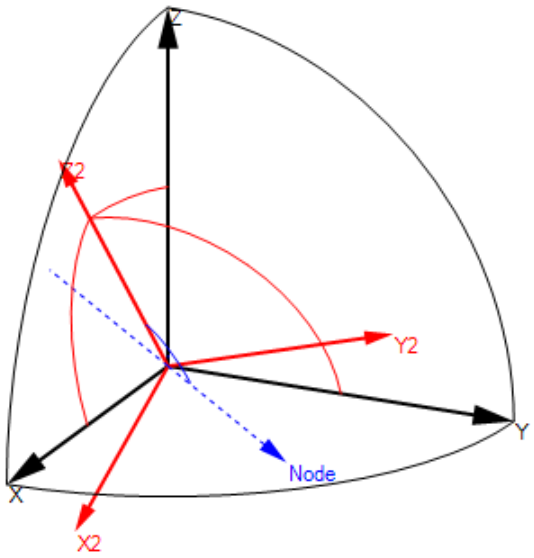

Spherical angles are typically used in grating theory.

# Cartesian Angles




Cartesian angles are rotations around the x- and y- axis.

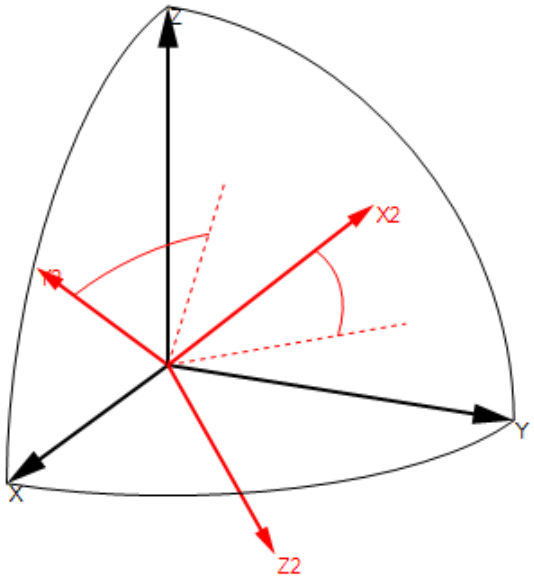
# Direction Angles



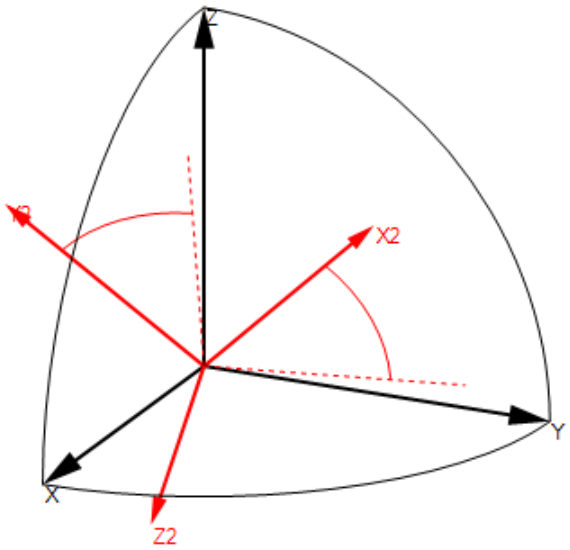

Direction angles expresses a tilt by direction cosines.

# Euler Angles

Euler angles

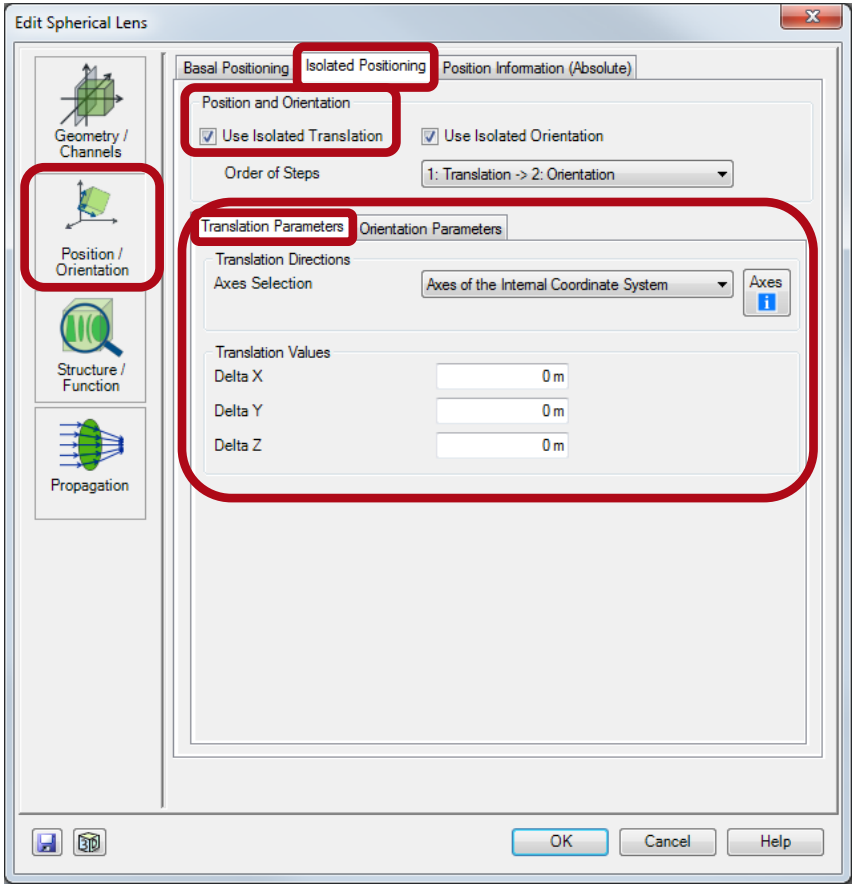


# Arbitrary Sequence of Axis Rotations



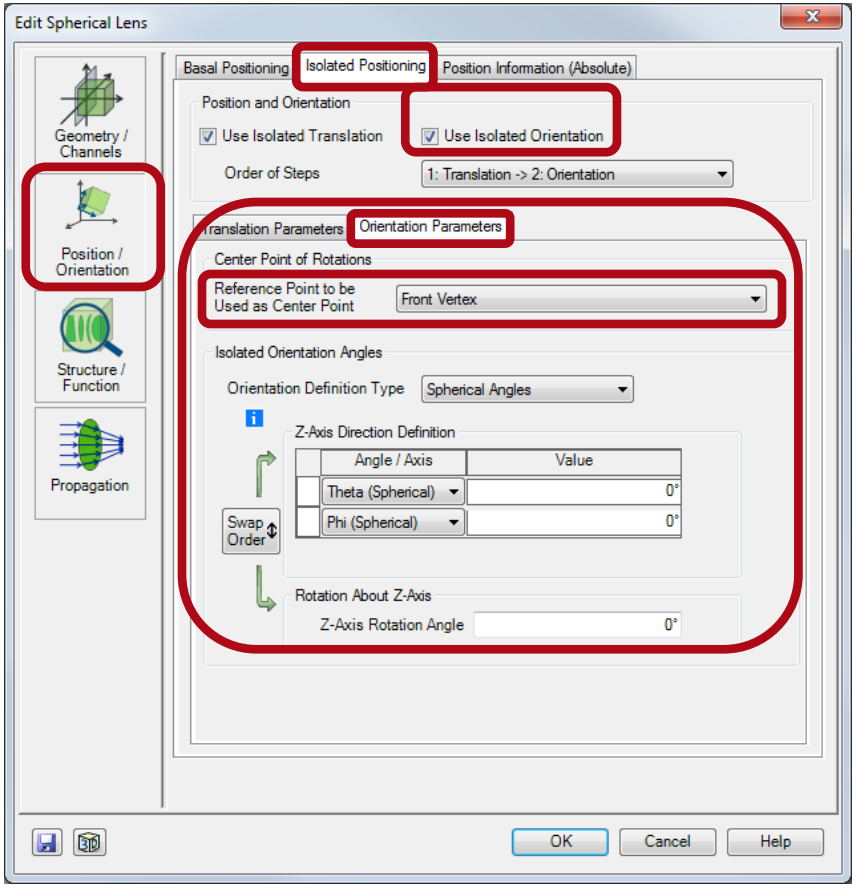

Arbitrary sequence of rotations around the coordinate axis

# Position & Orientation Settings




- Introduction of an additional offset relative to the basal position of the element.

# Position & Orientation Settings

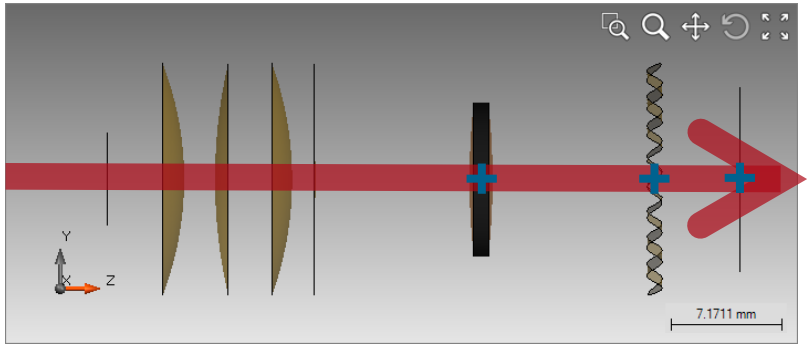



- Introduction of an additional tilt relative to the basal position of the element.
- This requires also the determination of an reference point for the rotation (pivot point).

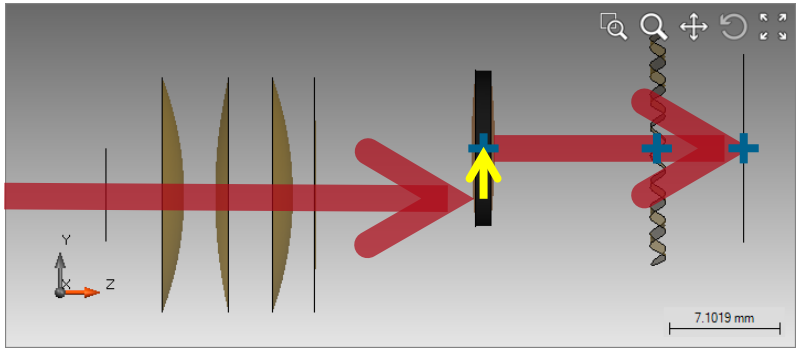
# Basal vs Isolated Position/Orientation: Shift

***Shift in y-direction***

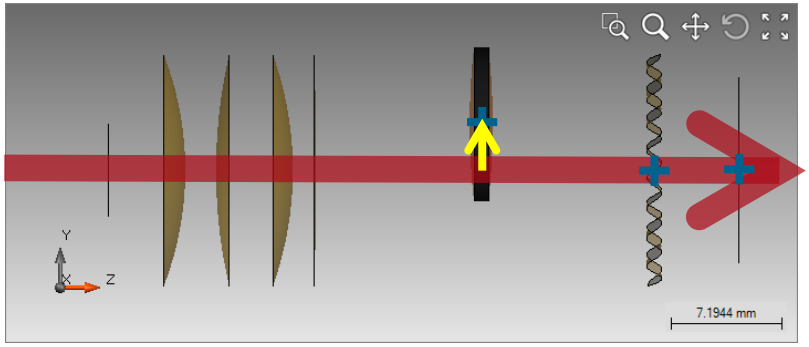
Original System




System with Shifted Lens via Basal Positioning Settings



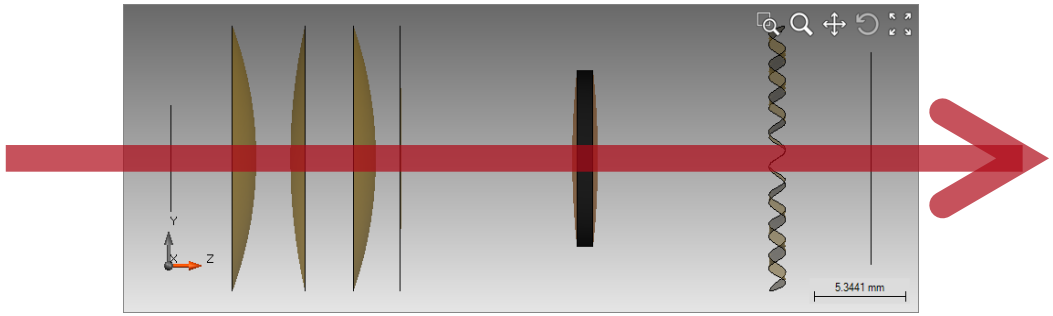

System with Shifted Lens via Isolated Settings



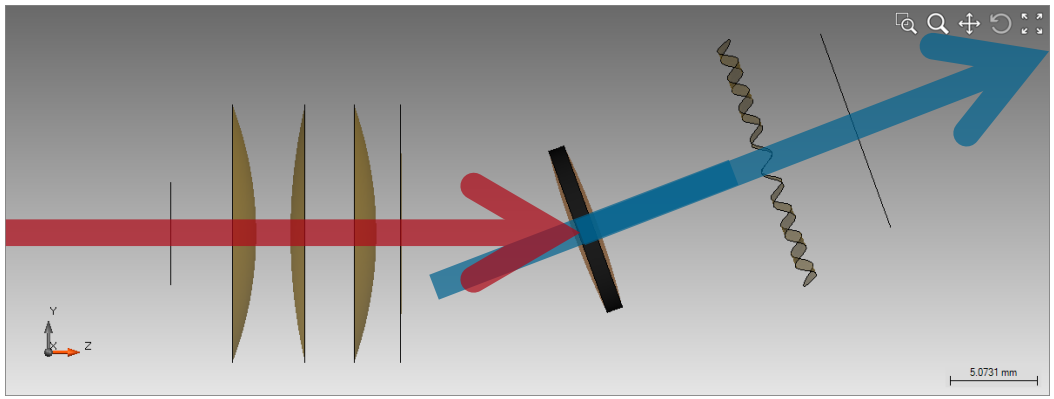
# Basal vs Isolated Position/Orientation: Tilt

***20° Tilt***

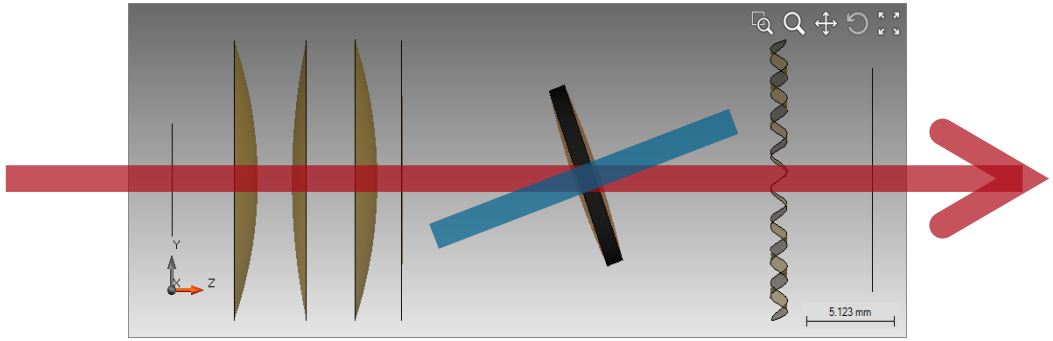
Original System




System with Tilted Lens via Basal Orientation Settings




System with Tilted Lens via Isolated Settings

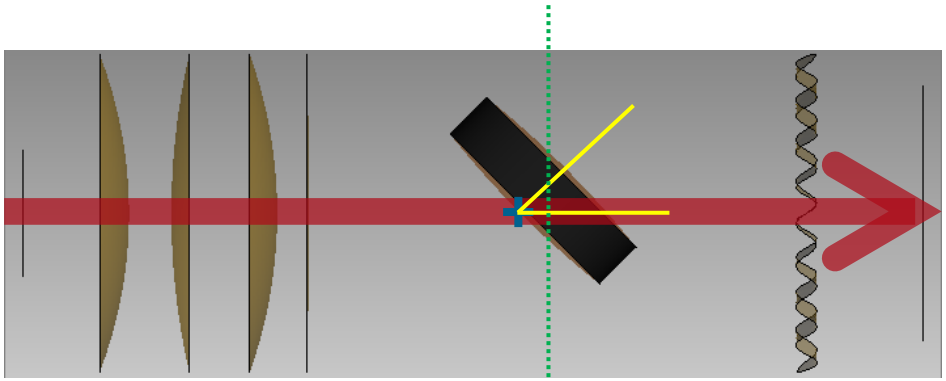


# Reference Points for Isolated Tilt

***45° Tilt***

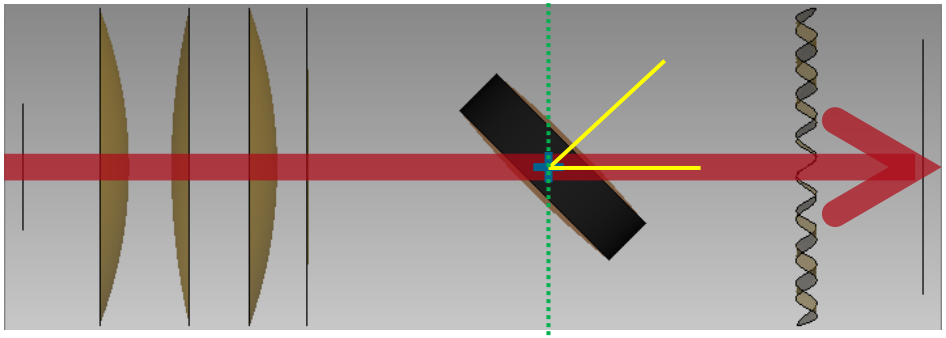
Center Point of Rotations

Reference Point to be Used as Center Point: Maximum Extension Plane #1



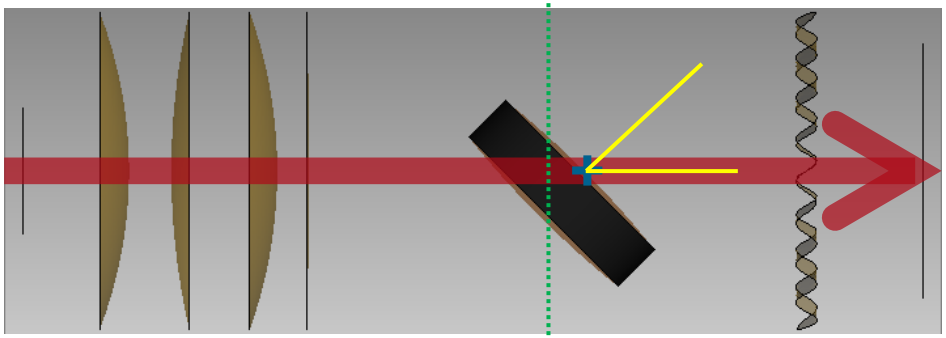
Center Point of Rotations

Reference Point to be Used as Center Point: Center of the Lens



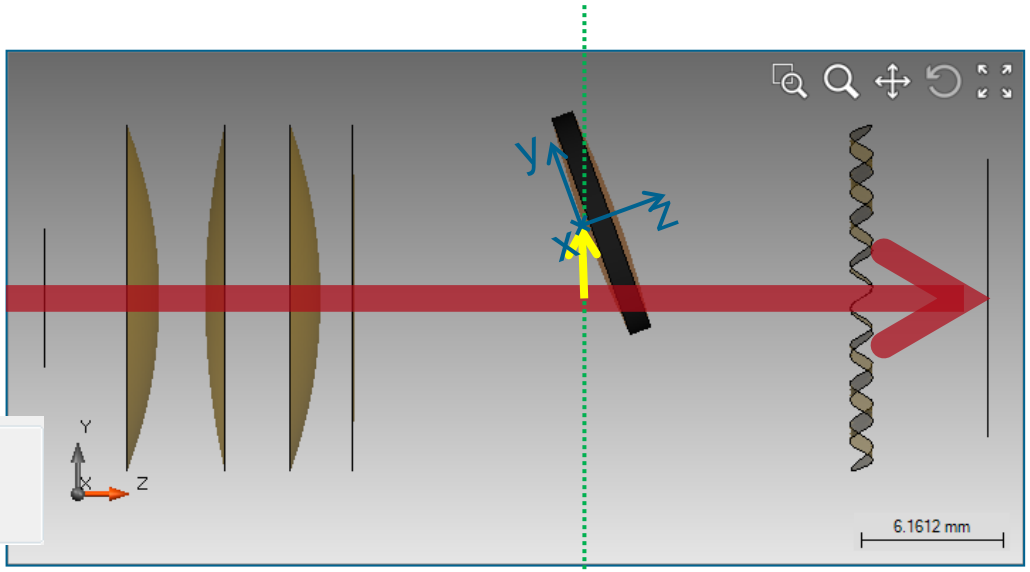
Center Point of Rotations

Reference Point to be Used as Center Point: Maximum Extension Plane #2



# Order of Isolated Positioning Steps

***Shift in y-direction and 20° Tilt***

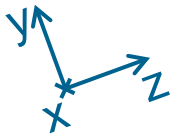



Position and Orientation

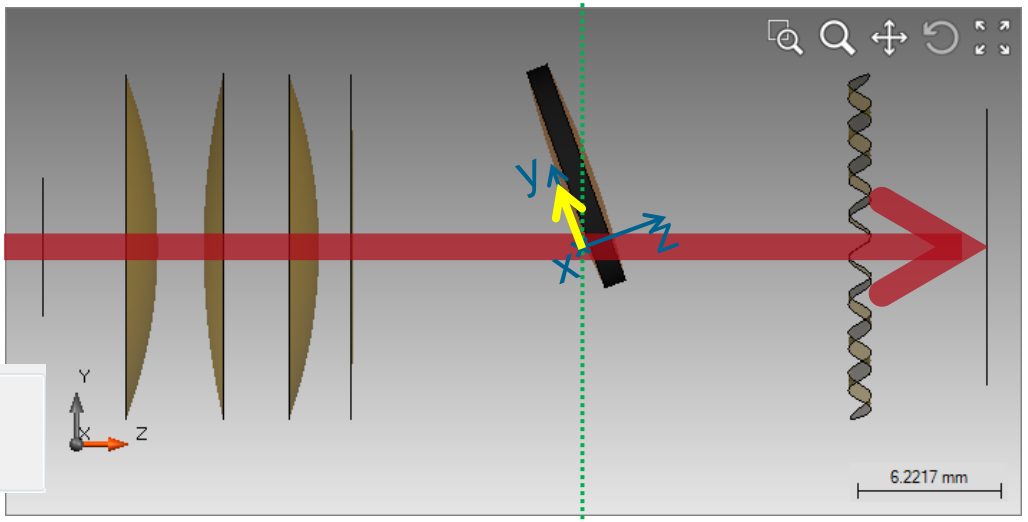
Use Isolated Translation  Use Isolated Orientation

Order of Steps: 1: Translation -> 2: Orientation

= Yellow Shift Vector




= Internal Coordinate System with its origin as pivot




Position and Orientation

Use Isolated Translation  Use Isolated Orientation

Order of Steps: 1: Orientation -> 2: Translation

# Summary

- VirtualLab allows the specification of tilts and offsets of optical components and detectors.
- Basal and isolated positioning can be used.
- *Coordinate Break* element allows change of direction and position of the optical axis.